

# Space Science Activities in China

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*2006-07-23*

# Outline

- **Recent Advances in Double Star Program**
- **KuaFu**
  - Solar Storm, Aurora and Space Weather Exploration
- **SMESE**
  - Small Mission on Exploration of Solar Eruption
- **Space Physics Exploration Roadmap**
- **Meridian Project**
  - Meridian Space Weather Monitoring Project

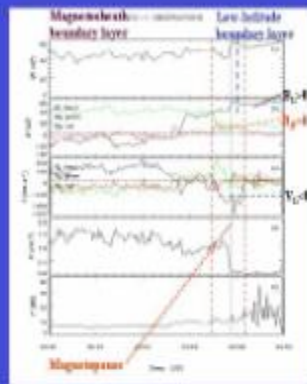
# Status of DSP



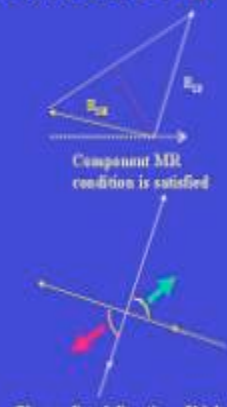
- The DSP mission has been officially extended to the end of 2006.
- By May 2006, TC-1 has obtained a total amount of 175G data, while TC-2 145G.

# Double Star Project

TC-1 Observation of MR for IMF  $B_z > 0$   
(Location of MR is northward of TC-1)



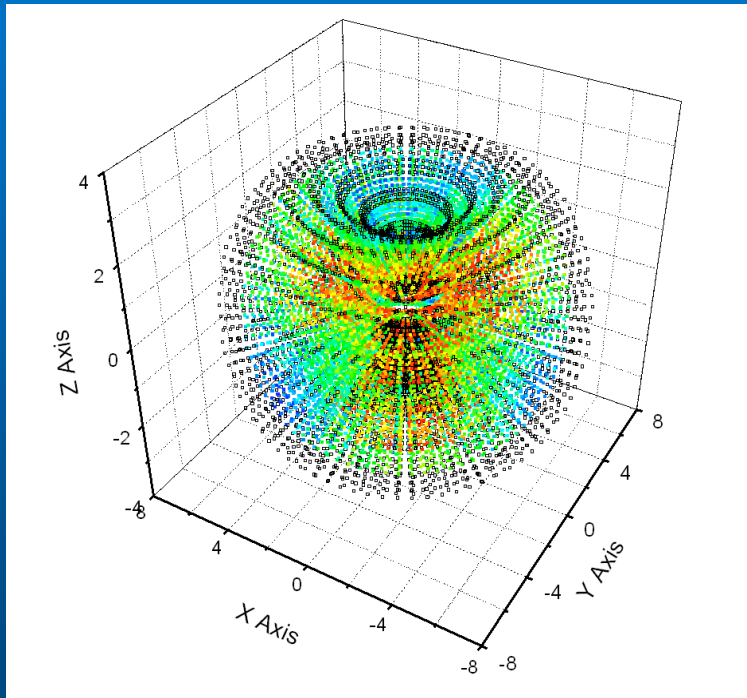
MR for IMF  $B_z > 0$  Contributes to the formation of LBL



The predicted direction of high-speed flow is consistent with observations

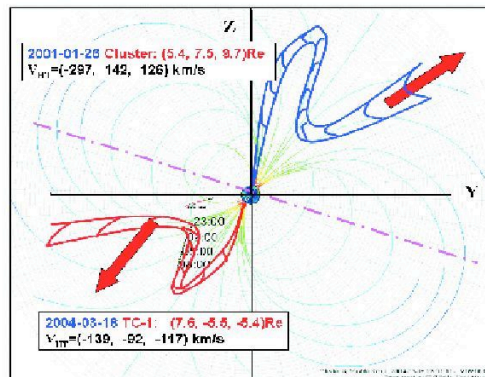
- Data analysis and theoretical study (modeling) related to DSP are very active in China and worldwide.
- First results (24 papers) have been published in *Annales Geophysice*.

# Example 1:



- By using of the Image Data from the NUADU/TC2, the distribution of the neutral atom origins has been deduced.

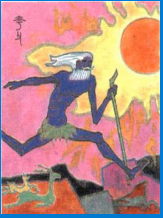
## Example 2:



From Xiao et al., 2005

2004年3月18日及2001年1月26日向阳面磁层顶磁通管全  
球结构示意图

- The occurrence of the magnetic reconnection at the dayside magnetopause under the northward IMF has been observed

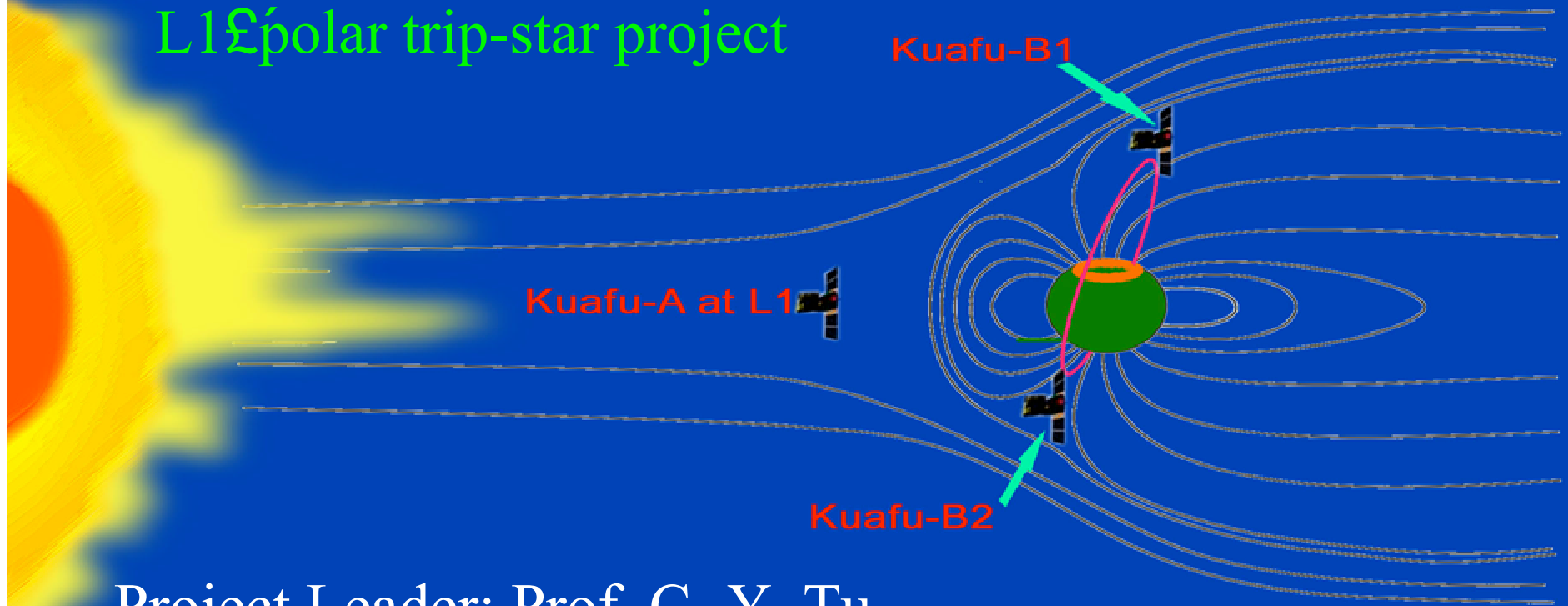


# KuaFu

## Solar Storm, Aurora and Space Weather Exploration

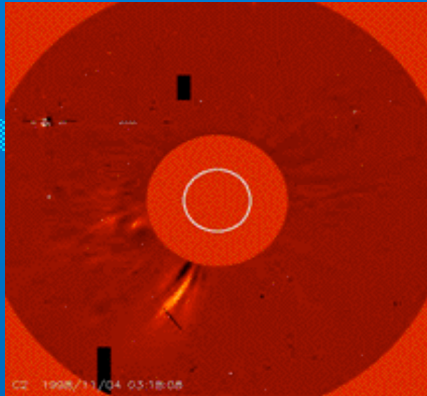
Expected Launch Date: 2012

L1 polar trip-star project



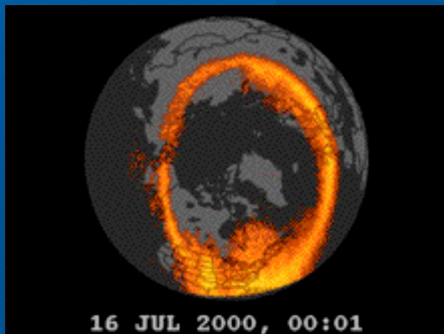
Project Leader: Prof. C.-Y. Tu

## KuaFu-A at L1



Solar EUV emission  
White light CME  
Radio wave measurement  
local plasma and magnetic field  
High energy particles

## KuaFu-B1+B2 polar orbit



24 hours Aurora Image,  
Magnetic field  
High energy particles



# Scientific Objectives

To observe the complete chain of disturbance from the solar atmosphere to the geo-space:

- Solar flares, CMEs,
- Interplanetary clouds, shock waves,
- Their geo-effectiveness, such as sub-storms and magnetic storms, aurora activities

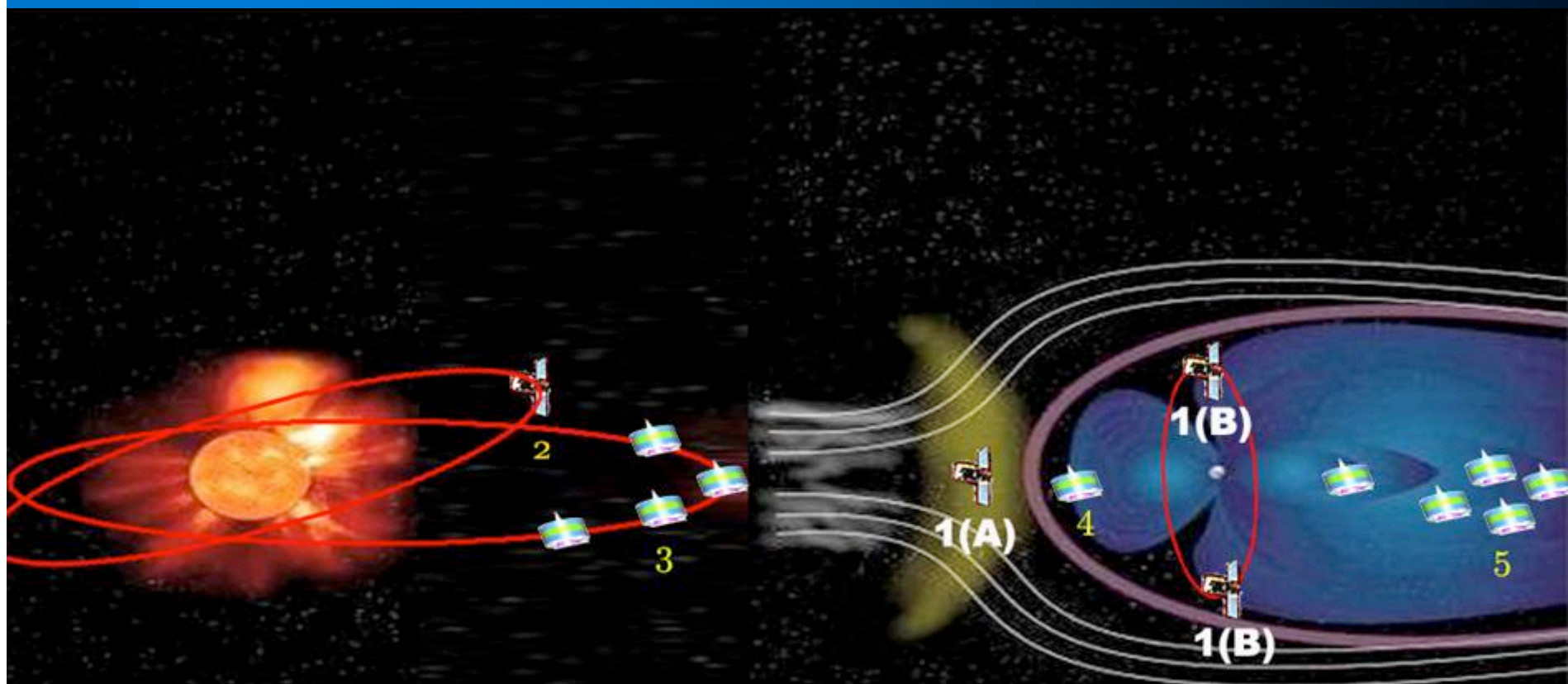
# KuaFu-A Payload

Instrument	Mass (kg)	Power (w)	Data Rate (bps)
EUV/FUV Disk Imager	25	20	100k
Coronal Dynamics Imager	35	35	50k
Radio Burst Instrument	12	10	4k
Solar Wind Instrument Package	6	6	4k
Solar Energetic Particle Sensor	8	10	1k
X-ray/_-ray Detector	3	5	1k
Total	89	86	160

# KuaFu-B Payload

Instrument	Mass (kg)	Power (w)	Data Rate (bps)
EUV Aurora Monitoring Camera	21	11	<0.5 M
FUV Aurora Spectrograph	20	4.4	
Wide-Field Aurora Imager	1.5	10	TBC
Fluxgate Magnetometer	3	4.2	3k
High Energy Particle Experiment	3	4	1k
Neutral Atom Imager	4	4	1k
Total	~60	~50	~0.5 M

# Conjunct Observation



1(A): 夸父-A (1颗)

2: Solar Orbiter (1颗)

3: Solar Wind Sentinel (4颗)

1(B): 夸父-B (2颗)

4: RBST (2颗)

5: MMS (4颗)

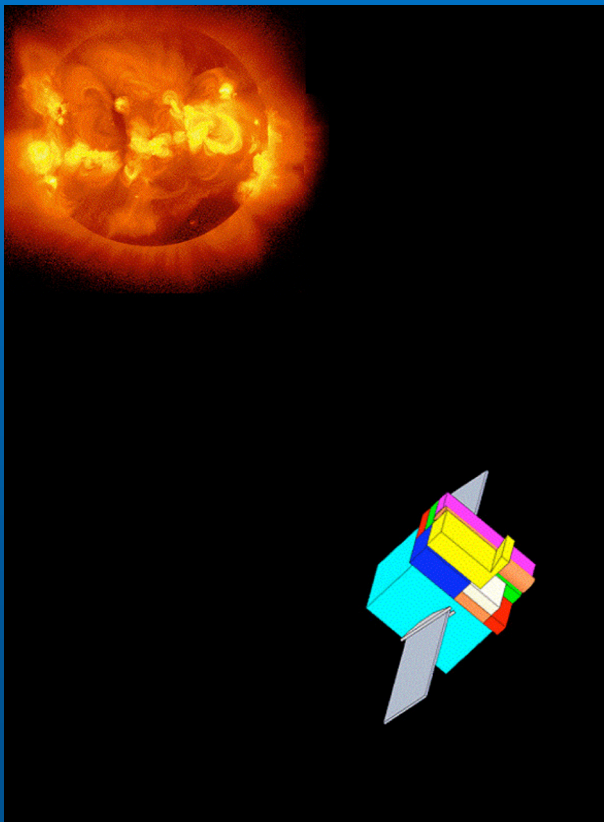
# Status

- The Comprehensive Review is under way.
- The KuaFu Promotion Committee have recently been established.

# An Brief Introduction to SMESE

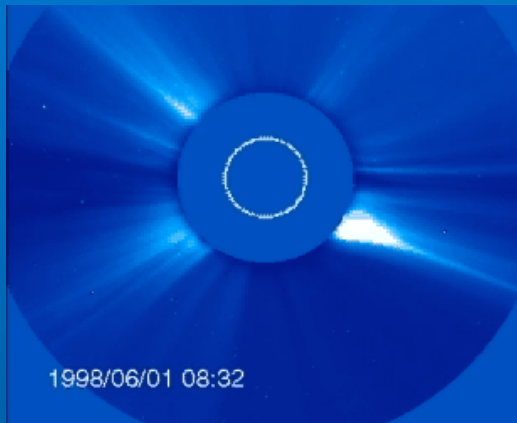
Small Mission on Exploration of Solar Eruption

## France-China Joint Mission

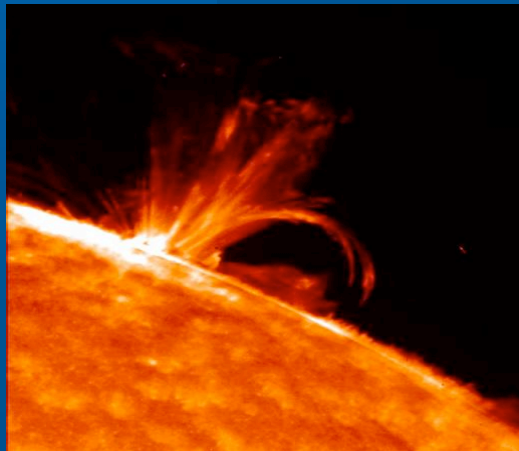


- Purple Mountain Observatory, CAS, China
- Nanjing University, China
- Center for Space Science and Applied Research, CAS, China
- National Astronomical Observatory, CAS, China
- Institut d'Astrophysique Spatiale, CNRS, France
- Observatoire de Paris, France
- Max-Planck-Institute For solar System Research, Germany

# Background



The solar corona is the seat of variability which involves basic processes of plasma-magnetic field interaction in the universe.



Explosive energy conversion in the corona has two major types of manifestation:

- **coronal mass ejections (CMEs)**
- **solar flares**

Both are basically driven by instabilities of the magnetic field in the corona.

# SMESE Scientific Objectives

(or the questions to be answered)

- What triggers coronal mass ejections and how are they accelerated in the low corona and out of the corona into the Heliosphere?
- How are CMEs and flares related ? More specifically : what is the partition energy between large-scale mass motion, small-scale heating, and particle acceleration ?
- How does the Sun accelerate particles to relativistic energies ? Low and high energy particles : accelerated by the same mechanism ? What are the highest energies to which charged particles can be accelerated in the solar corona?
- How do radiation, conduction and energetic particles participate in the transport of energy in the solar atmosphere?



# Brief Description

## **SMESE:**

to observe the solar flares and CMEs for the next Solar Maximum

## **Main Goals:**

- To establish the interconnections between flares and CMEs;
- To follow the disc source region of CME;
- To diagnose the high energy particles accelerated by flares and CMEs;
- To study the energy transportation mechanisms.

all of these are the key ingredients of space weather!

	Wavelength/ Energy	Field of View	Spatial resolution	Time resolution
<b>LYOT: Ly <math>\alpha</math> Imager</b>	121.6 nm	Full Disk	1 arcsec	30s
<b>LYOT: Ly <math>\alpha</math> coronagraph</b>	121.6 nm	>5 solar radii	2.5 arsec	2 min
<b>LYOT: EUV imager</b>	19.5 nm	Full Disk	1 arcsec	30 s
<b>DESIR: Detection of Solar Infra red Radiation</b>	35 and 150 $\mu\text{m}$	Full Disk	50 arcsec at 35 $\mu\text{m}$	100 ms
<b>HEBS: HEBS-X</b>	10-500 keV	Full Disk	Full Disk	1s down to 32 ms
<b>HEBS HEBS-G</b>	100 keV- 10 MeV 10 MeV -600 MeV	Full Disk	Full Disk	1s down to 32 ms

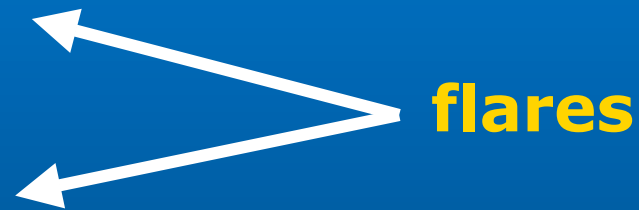
	<b>Mass (kg)</b>	<b>Volume (cm<sup>3</sup>)</b>	<b>Power (W)</b>	<b>Telemetry</b>
<b>LYOT:</b>	27	58000	39	28 G/day
<b>DESIR</b>	10	20000	10	2 G/day
<b>HEBS</b>	20	23000	18	1 G/day
<b>ECU (computer +mass memory)</b>	4	4000	4	
<b>TM/TC package</b>	2	2000	2	
<b>Structure</b>	12			
<b>Total</b>	75	107000	73	31G/day

**SMESE is a small satellite!**

# Historic role

## Missions for solar peak years:

- Cycle 21<sup>st</sup>: SMM
- Cycle 22<sup>nd</sup>: YOHKOH
- Cycle 23<sup>rd</sup>: RHESSI

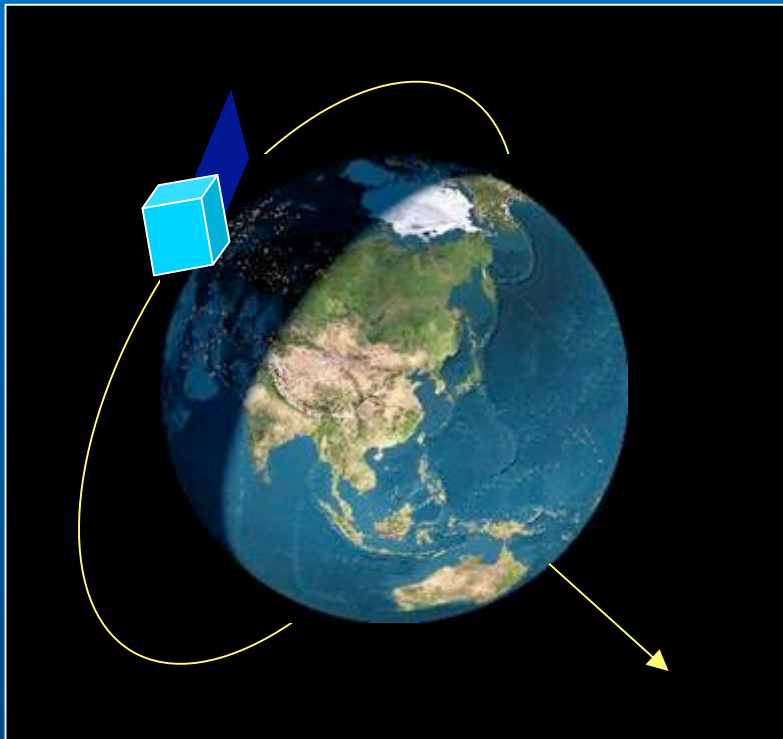


## Cycle 24<sup>th</sup>: SMESE



It may be the unique mission specially for the 24<sup>th</sup> solar peak years!

# Mission Profile



- Mass of payloads: 75 kg
- Power available for the payload: 90 - 120W depending on the season
- Size of payloads: 600°600°600mm
- Attitude: Solar-pointed, three-axis stability
- Stability: 0.5 arcsec over 10s
- Telemetry: 31 Gbits/day
- Data recorder: 31 Gbits (solid state)
- Orbit: Polar, Sun Synchronous, 650-750 km
- Launch: 2010
- Lifetime: 2 years minimum
- Communication: X-band

# Science management

**Science Definition Team (SSDT)** has been set up to validate the work of the SMESE consortium during the definition phase. All through the development stages, it ensures that the initial scientific goals are satisfied.

Liaison with ground or space projects.

SSDT membership:

**China :** Cheng Fang (vice chairman, Nanjing University), Weiqun Gan (Purple Mountain Observatory),

Chi Wang (CSSAR), Yihua Yan (National Astronomical Observatory)

**France :** Claude Barat (CESR), Jean Heyvaerts (Strasbourg Observatory), Gérard Trottet (LESIA),

Jean-Claude Vial (chairman, IAS)

**Madhulika Guhathakurta (NASA)**

**Richard G. Marsden (ESA/ESTEC)**

# Status

- The phase 0/A Kick Off Meeting has been held in Paris on March 22-24, 2006;
- The Mission Design Review has been held on June 26, 2006. The final report of the review group will be released by the end of August;
- A preliminary requirement review is planned for April 2007;

# Status

- On the China side, the preliminary designs of the HEBS instrument and IDHP (Instrument Data Handling Processor) have been funded by CNSA and the support to carry out phase B studies is expected by mid 2007.
- The CNES Scientific Program Committee is expected to give its recommendations regarding the scientific priorities to CNES executive between Oct. 2006 and Feb. 2007.

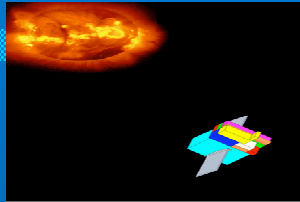


# Roadmap for Space Physics Exploration

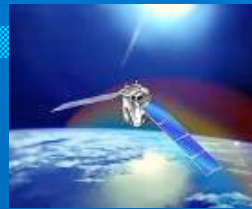
DSP



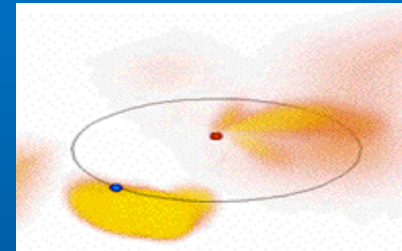
SMESE



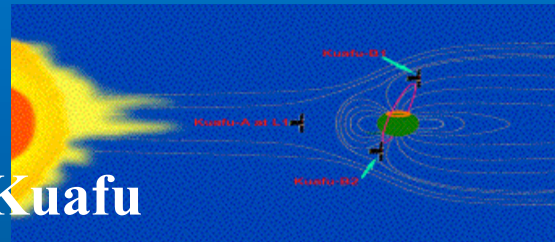
MIT



Interplanetary Space



Kuafu



2005

2010

2015

2020

2025

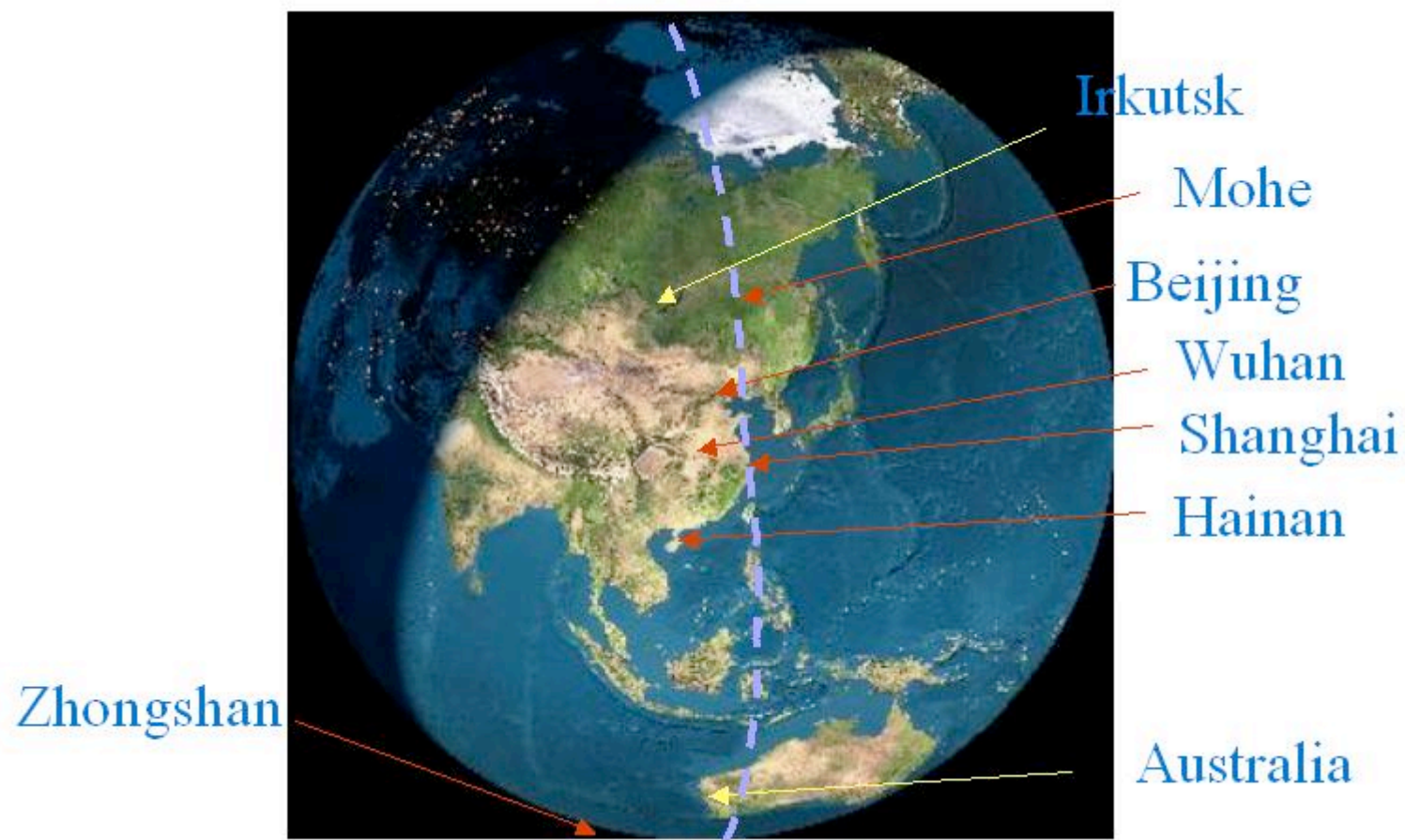


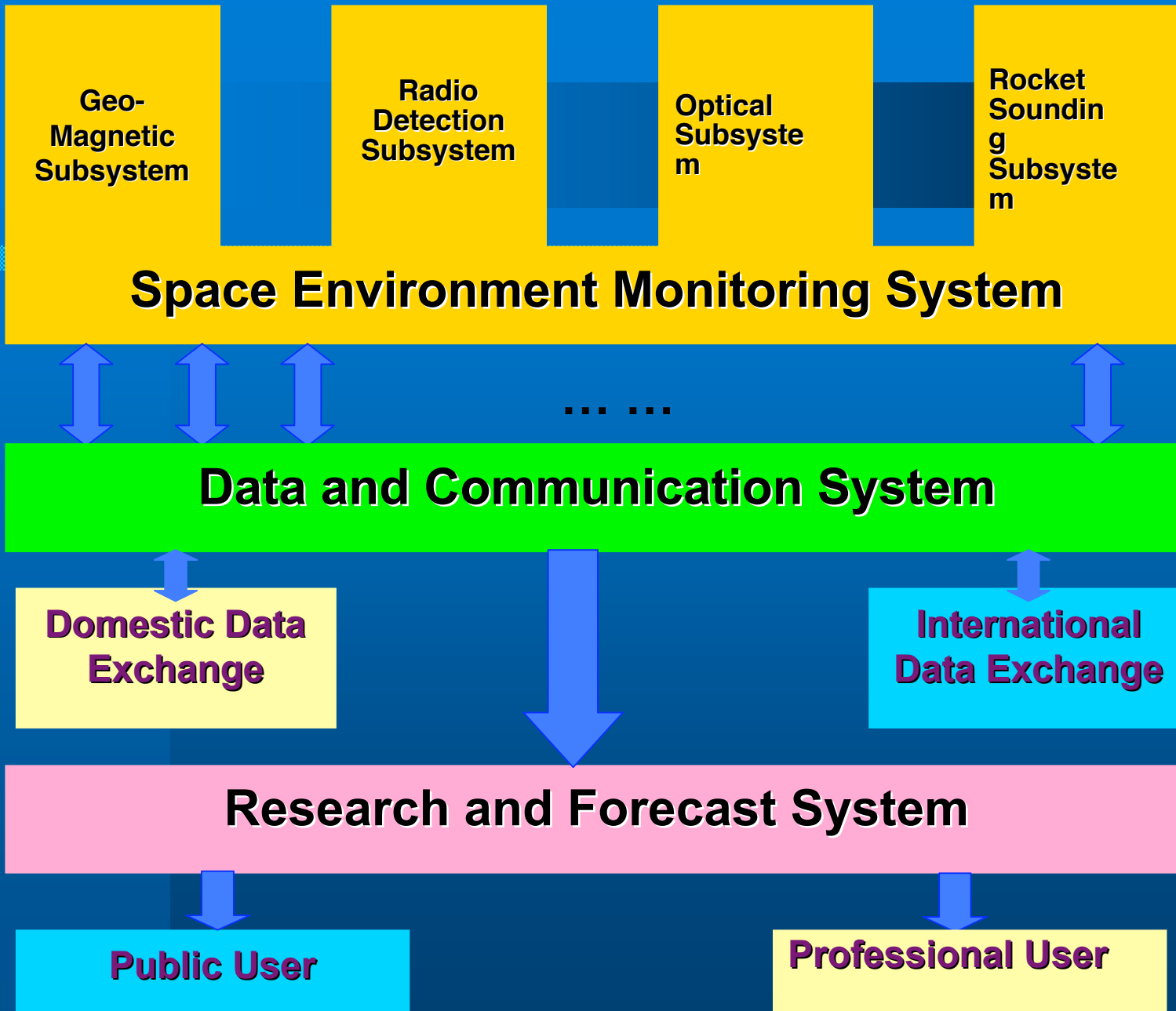
Mars Space Environment Exploration



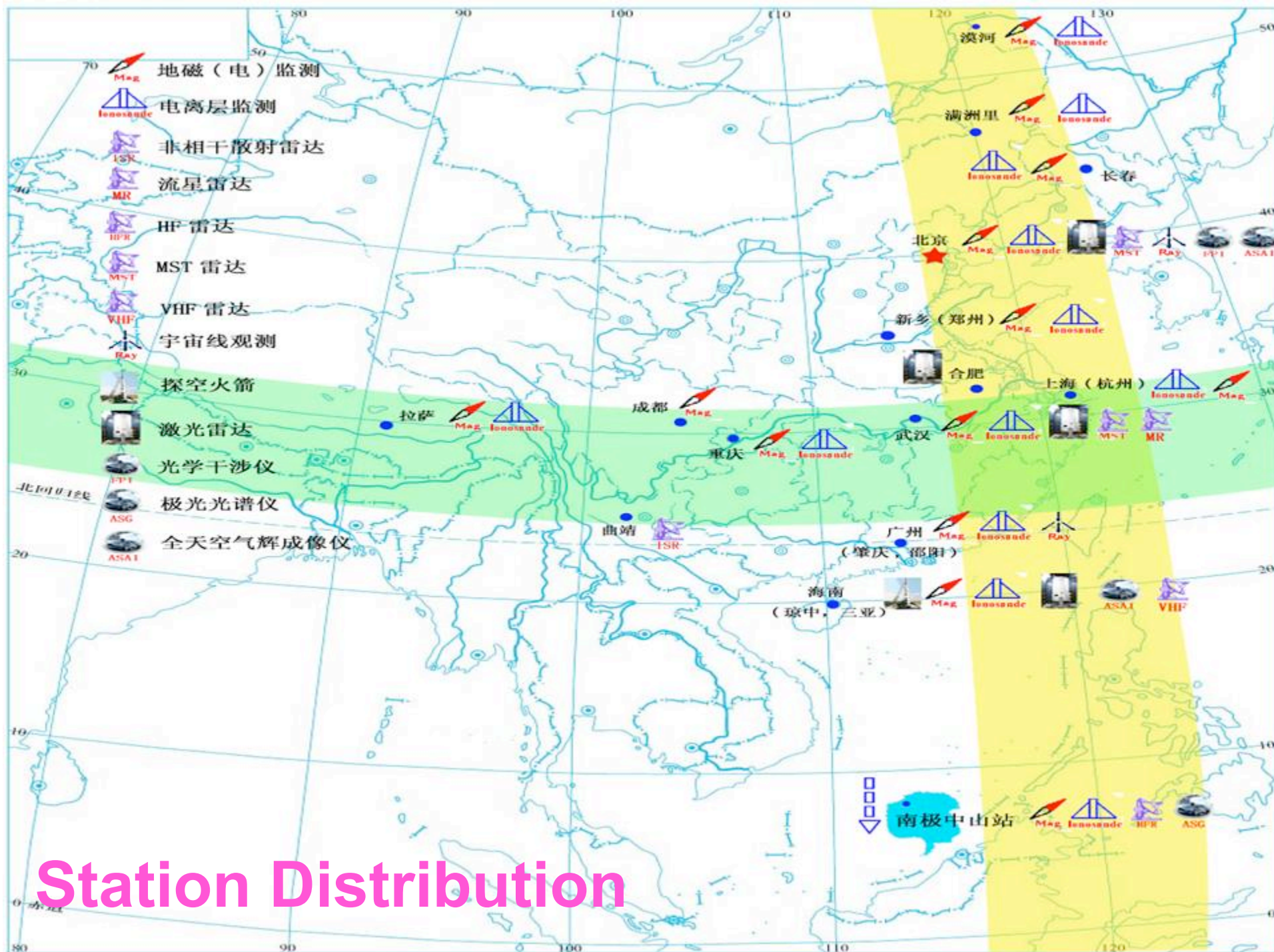
# **Meridian Space Weather Monitoring Project (Meridian Project)**

It is a Chinese multi-station chain along 120°E to monitor space environment, starting from Mohe, the most northern station in China, through Beijing° Wuhan° Guangzhou and extended to Chinese Zhongshan station in the Antarctic.









No	Station	Lat.	Lon.	Types of Observations
01	Mohe	53.5N	122.4E	Geomagnetic
02	Manzhouli	49.6N	117.4E	Geomagnetic, Ionospheric
03	Harbin	45.5N	126.5E	, Ionospheric
04	Changchun	44.0N	125.2E	Geomagnetic
05	Beijing	40.3N	116.2E	Geomagnetic, Ionospheric, Lidar, MST radar, Optical atmospheric, IPS, Cosmic rays
06	Xinxiang	34.6N	113.6E	Geomagnetic, Ionospheric
07	Wuhan	30.5N	114.6E	Geomagnetic, Ionospheric, Lidar, MST radar
08	Guangzhou	23.1N	113.3E	Geomagnetic, Ionospheric, Cosmic rays
09	Hainan	19.0N	109.8E	Geomagnetic, Ionospheric, Lidar
10	Zhongshan	69.4S	76.4E	Geomagnetic, Ionospheric
11	Shanghai	31.1N	121.2E	Geomagnetic
12	Chongqing	29.5N	106.5E	Geomagnetic, Ionospheric
13	Chengdu	31.0N	103.7E	Geomagnetic, Ionospheric
14	Qijing	25.6N	103.8E	Incoherent Scattering Radar (ISR)
15	Lhasa	29.6N	91.0E	Geomagnetic, Ionospheric

# International Collaboration



**The International Space Weather Meridian Circle Program (ISWMCP), proposal to connect 120°E and 60°W meridian chains of ground based monitors and enhance the ability of monitoring space environment worldwide.**

# Status

- The proposal of the Meridian Project has been approved by the China National Development and Reform Commission as a key scientific project in Aug., 2005;
- The feasibility study of the Meridian Project has been evaluated and approved in June, 2006. The total budget is about 22 million US\$;
- The Meridian Project is expected to be finished by the end of 2009.



# Summary

- **DSP** is the first Chinese scientific exploration mission, and has been very successful.
- The comprehensive review of **KuaFu** project and the phase A study of **SMESE** are under way.
- **Meridian Project** has officially approved by Chinese government, and will be finished by 2009.
- International cooperation are encouraged by Chinese government to make joint effort to promote space science missions.



**THANK  
YOU**